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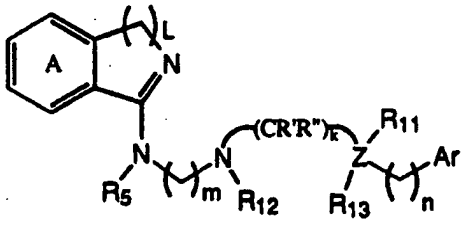
(54) Title: 1-(N'-(ARYLALKYLAMINOALKYL)) AMINOISOINDOLES AS DOPAMINE RECEPTOR LIGANDS



(1)

(57) Abstract

Disclosed are compounds of formula (1) or the pharmaceutically acceptable salts thereof, wherein the 6-membered A ring may be optionally substituted with up to four groups independently selected from halogen, hydroxy, lower alkyl, or lower alkoxy; Ar represents optionally substituted aryl or heteroaryl, Z represents carbon or nitrogen provided that where Z is carbon, R_{11} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy, or phenyl optionally substituted with one or two groups selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and where Z is nitrogen, R_{11} represents an electron pair; R_5 is hydrogen or lower alkyl; L and m represent integers; n is 0, or an integer; R_{12} and R_{13} independently represent lower alkyl; or together may together form an optionally substituted 5-11 membered ring with the nitrogen atoms to which they are bonded; CR'R" represents a methylene group optionally substituted with lower alkyl; and k is an integer of from 1 to 3, which compounds are useful in treating various neuropsychological disorders including, for example, schizophrenia, dementia, depression, anxiety, Parkinson-like motor disorders and motion disorders related to the use of neuroleptic agents.

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1-(n'-(arylalkylaminoalkyl)) aminoisoindoles as dopamine receptor ligands

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to aminoisoindole derivatives which selectively bind to brain dopamine receptor subtypes. More specifically, it relates to 1-(N'-(arylalkylaminoalkyl)) aminoisoindoles and to pharmaceutical compositions comprising such compounds. It further relates to the use of such compounds in treating various neuropsychochological disorders.

Description of the Related Art

Schizophrenia or psychosis is a term used to describe a group of illnesses of unknown origin which affect approximately 2.5 million people in the United States. These disorders of the brain are characterized by a variety of symptoms which are classified as positive symptoms (disordered thought, hallucinations and delusions) and negative symptoms (social withdrawal and unresponsiveness). These disorders have an age of onset in adolescence or early adulthood and persist for many years. The disorders tend to become more severe during the patient's lifetime and can result in prolonged institutionalization. Within the United States of America, approximately 40% of all hospitalized psychiatric patients suffer from schizophrenia.

During the 1950's physicians demonstrated that they could successfully treat psychotic (schizophrenic) patients with medications called neuroleptics. This classification of antipsychotic medication was based largely on the activating (neuroleptic) properties of the nervous system by these drugs. Subsequently, neuroleptic agents were shown to increase the concentrations of dopamine metabolites in the brain. This finding suggested that altered neuronal firing of the dopamine system contributed in some way to the aberrant behavior observed in schizophrenic patients. Additional evidence indicated that dopamine could increase the activity of adenylate cyclase in the corpus striatum, an effect reversed by neuroleptic agents. Thus, cumulative evidence from these and later experiments strongly suggested that the neurotransmitter dopamine was involved in schizophrenia.

One of the major actions of antipsychotic medication is the blockade of dopamine receptors in brain. Several dopamine systems appear to exist in the brain and at least five classes of dopamine receptors appear to mediate the actions of this transmitter. These dopamine receptors differ in their pharmacological specificity and were originally classified on the basis of their ability to bind various dopaminergic ligands.

The butyrophenones are a class of drugs containing many potent antipsychotic drugs. Perhaps the most prominent member of this class of compounds is the antipsychotic drug haloperidol (chemical name). Haloperidol binds relatively weakly at the major dopamine receptor subtype which activates adenylate cyclase (commonly classified as the D_1 dopamine receptor). In contrast, haloperidol displayed binding affinity at a dopamine receptor subtype which suppressed the activity of adenylate cyclase (commonly classified as D_2 receptors) in the subnanomolar range.

Recently, three additional dopamine receptor subtypes have been identified using the often congruent sciences of receptor pharmacology and molecular biology. These new dopamine receptors have been labeled as D3, D4, and D_5. The D_3 and D_4 subtypes are pharmacologically related to the D_2 receptor via their ability to suppress the activity of adenylate cyclase. Conversely, the D_5 receptor is classified as a "D_1-like" dopamine subtype through its ability to stimulate cyclase activity.

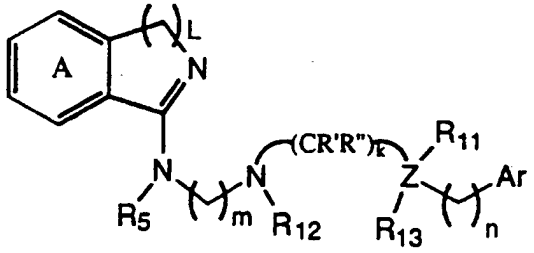
Recently, a new group of drugs (such as sulpiride and clozapine) have been developed with a lesser incidence of extrapyramidal side effects (EPS) than classical neuroleptics. In addition, there is some indication that they may be more beneficial in treating negative symptoms in some patients. Since all D_2 blockers do not possess a similar profile, hypotheses underlying the differences have been investigated. Major differences have been detected in the anticholinergic actions of these drugs. It has also been suggested that the dopamine receptors in motor areas may differ from those in the limbic areas which are thought to mediate the antipsychotic responses. The existence of the D_3, D_4 and D5 and other as yet undiscovered dopamine receptors may contribute to this profile. Some of the atypical compounds possess similar activity at D_2, D_3 and D_4 receptors. The examples of this patent fall into this general class of molecules.

Using molecular biological techniques it has been possible to clone cDNAs coding for each of the pharmacologically defined receptors. There are at least two forms of D1 which have been identified as D_1 and D_5, and two forms of D_2, identified now as D2 and D_4 dopamine receptors. In addition, there is at least one form of D_3 dopamine receptor. The 1-(N'-(arylalkylaminoalkyl))aminoisoindoles of this invention possess differential affinities for each receptor subtype.

SUMMARY OF THE INVENTION

This invention provides novel compounds of Formula 1 which interact with dopamine receptor subtypes.

The invention provides pharmaceutical compositions comprising compounds of Formula 1. The invention also provides compounds useful in treating affective disorders such as schizophrenia and depression as well as certain movement disorders such as Parkinsonism. Furthermore, compounds of this invention are useful in treating the extrapyramidal side effects associated with the use of conventional neuroleptic agents. Since particularly dopamine D3 and D4 receptor subtypes are concentrated in the limbic system (Taubes, Science *265* (1994) 1034), which controls cognition and emotion, compounds which interact with these receptors are useful in the treatment of cognitive disorders. Such disorders may be the cognitive deficits which are a significant component of the negative symptoms (social withdrawal and unresponsiveness) of schizophrenia. Other disorders involving memory impairment or attention deficit disorders can also be treated with some of the compounds of this invention that interact specifically with dopamine D3 and/or D4 receptor subtypes. Accordingly, a broad embodiment of the invention is directed to a compounds of Formula 1



1

where

the 6-membered A ring may be optionally substituted with up to four groups independently selected from halogen, hydroxy, lower alkyl, or lower alkoxy;

Ar represents optionally substituted aryl or heteroaryl

Z represents carbon or nitrogen provided that

where Z is carbon, R_{11} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy, or phenyl optionally substituted with one or two groups selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

where Z is nitrogen, R_{11} represents an electron pair;

R_5 is hydrogen or lower alkyl;

L is an integer of from 1-4;

m is an integer of from 2-5;

n is 0, or an integer of from 1-4;

R_{12} and R_{13} independently represent lower alkyl; or together may represent $(CR_xR_y)_s$ where s is an integer of from 1-6 and R_x and R_y independently represent hydrogen or lower alkyl;

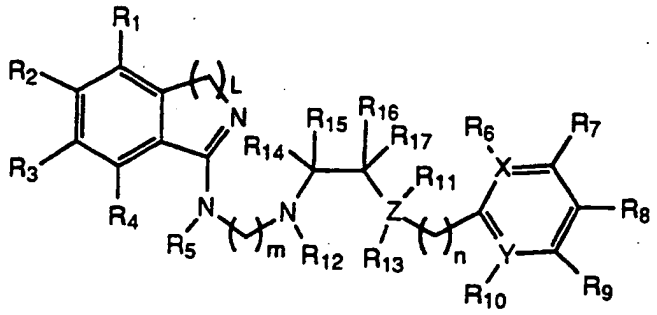
CR'R" represents a methylene group optionally substituted with lower alkyl; and

k is 0 or an integer of from 1 to 3.

Thus, the compounds of Formula 1 can be used in the treatment of various neuropsychochological disorders including, for example, schizophrenia, dementia, depression, anxiety, Parkinson-like motor disorders and motion disorders related to the use of neuroleptic agents.

DETAILED DESCRIPTION OF THE INVENTION

The novel compounds encompassed by the instant invention can be described by general formula 1:



1a

wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

X represents carbon or nitrogen provided that

where X carbon, R_6 represents hydrogen, halogen, hydroxy, lower alkyl having 1-6 carbon atoms, or lower alkoxy; and

where X is nitrogen, R_6 represents an electron pair;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

where Y is nitrogen, R_{10} represents an electron pair;

Z represents carbon or nitrogen provided that

where Z is carbon, R_{11} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy, or phenyl optionally substituted with one or two groups selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

when Z is nitrogen, R_{11} represents an electron pair;

R_5 is hydrogen or lower alkyl;

L is an integer of from 1-4;

m is an integer of from 2-5;

n is 0, or an integer of from 1-4;

R_{12} and R_{13} independently represent lower alkyl; or

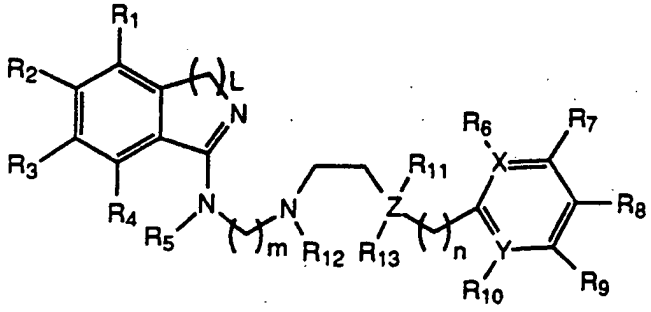
R_{12} and R_{13} taken together may represent $(CR_XR_Y)_S$ where s is an integer of from 1-6 and R_X and R_Y independently represent hydrogen or lower alkyl;

R_7 and R_8 together may represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

R_{14}, R_{15}, R_{16} and R_{17} are the same or different and represent hydrogen or lower alkyl.

Preferred compounds of Formula 1a are those where s is an integer of from 1-4, and most preferably from 2-3.

The present invention also encompasses compounds of Formula 2:



2

wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

X represents carbon or nitrogen provided that

where X carbon, R_6 represents hydrogen, halogen, hydroxy, lower alkyl having 1-6 carbon atoms, or lower alkoxy; and

where X is nitrogen, R_6 represents an electron pair;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

where Y is nitrogen, R_{10} represents an electron pair;

Z represents carbon or nitrogen provided that

where Z is carbon, R_{11} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy, or phenyl optionally substituted with one or two groups selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

when Z is nitrogen, R_{11} represents an electron pair;

R_5 is hydrogen or lower alkyl;

L is an integer of from 1-4;

m is an integer of from 2-5;

n is 0, or an integer of from 1-4;

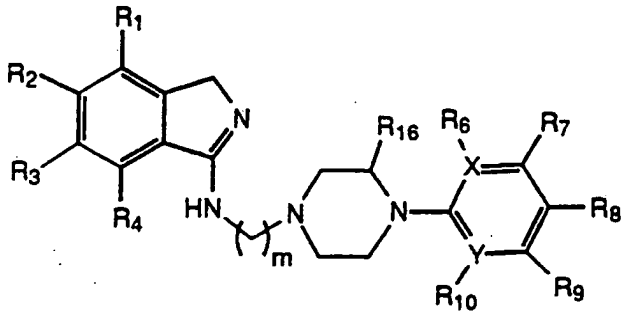
R_{12} and R_{13} independently represent lower alkyl; or

R_{12} and R_{13} taken together represent $(CH_2)_s$ where s is an integer of from 1-6;

R_7 and R_8 together may represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy.

Preferred compounds of Formula 2 are those where s is an integer of from 1-4, and most preferably from 2-3.

The present invention further encompasses compounds of Formula 3:



3

wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

R_{16} represents hydrogen or lower alkyl;

X represents carbon or nitrogen provided that

where X carbon, R_6 represents hydrogen, halogen, hydroxy, lower alkyl having 1-6 carbon atoms, or lower alkoxy; and

where X is nitrogen, R_6 represents an electron pair;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

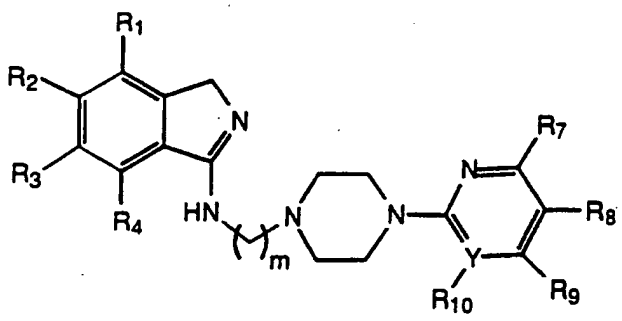
where Y is nitrogen, R_{10} represents an electron pair;

m is an integer of from 2-5;

R_7 and R_8 together optionally represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy.

Preferred compounds of formula 3 are those where m is 2, 3 or 4. Particularly preferred compounds of Formula 3 are those where m is 2 or 3; R_1, R_2, R_3, R_4 are hydrogen; R_7 and R_9 are hydrogen and R_8 is hydrogen, hydroxy, halogen or alkoxy. More particularly preferred compounds of Formula 3 are those where m is 2 or 3; R_1, R_2, R_3, R_4 are hydrogen; R_{16} is hydrogen or methyl; R_7 and R_9 are hydrogen; and R_8 is hydrogen, hydroxy or methoxy. Still other preferred compounds of formula 3 are those where m is 2 or 3; X and Y independently represent methylene optionally substituted with lower alkyl, preferably methyl; R_1, R_2, R_3, R_4 are hydrogen; R_{16} is hydrogen or methyl; R_7 and R_9 are hydrogen and R_8 is hydrogen, hydroxy or methoxy.

The present invention also encompasses compounds of Formula 4:



4

wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

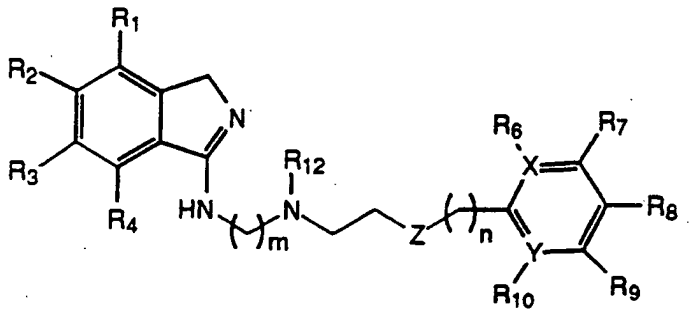
where Y is nitrogen, R_{10} represents an electron pair;

m is an integer of from 2-5; and

R_7 and R_8 together may represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy.

Preferred compounds of formula 4 are those where m is 2, 3 or 4. Particularly preferred compounds of Formula 4 are those where m is 2 or 3; and R_1, R_2, R_3, R_4 are hydrogen; R_7 and R_9 are hydrogen; and R_8 is hydrogen, hydroxy, halogen or alkoxy. More particularly preferred compounds of Formula 4 are those where m is 2 or 3; and R_1, R_2, R_3, R_4 are hydrogen; R_7 and R_9 are hydrogen; and R_8 is hydrogen, hydroxy or methoxy.

The present invention also encompasses compounds of Formula 5:



5

wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

X represents carbon or nitrogen provided that

where X carbon, R_6 represents hydrogen, halogen, hydroxy, lower alkyl having 1-6 carbon atoms, or lower alkoxy; and

where X is nitrogen, R_6 represents an electron pair;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

where Y is nitrogen, R_{10} represents an electron pair;

Z represents CH_2 or nitrogen;

m is an integer of from 2-5;

n is 0, or an integer of from 1-4;

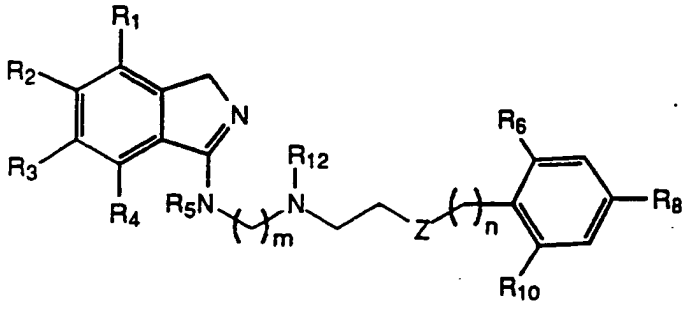
R_{12} represents hydrogen or lower alkyl; and

R_7 and R_8 together optionally represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy.

Preferred compounds of formula 5 are those where m is 2, 3 or 4 and n is 0. Particularly preferred compounds of Formula 5 are those where R_{12} is hydrogen or alkyl; m is 2, n is 0; Z is

CH_2; R_1, R_2, R_3, R_4 are hydrogen; R_7 and R_9 are hydrogen; and R_8 is hydrogen, hydroxy, halogen or alkoxy. More particularly preferred compounds of Formula 5 are those where R_{12} is hydrogen or methyl; m is 2; n is 0; Z is CH_2; and R_1, R_2, R_3, R_4 are hydrogen; R_7 and R_9 are hydrogen; and R_8 is hydrogen, hydroxy or methoxy.

In addition, the present invention provides compounds of Formula 6:



6

wherein:

R_1, R_2, R_3, R_4 and R_8 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

R_6 and R_{10} independently represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

Z represents CH_2 or nitrogen;

m is an integer of from 2-5;

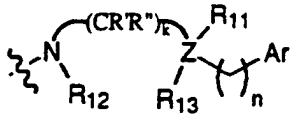
R_5 represents hydrogen or lower alkyl;

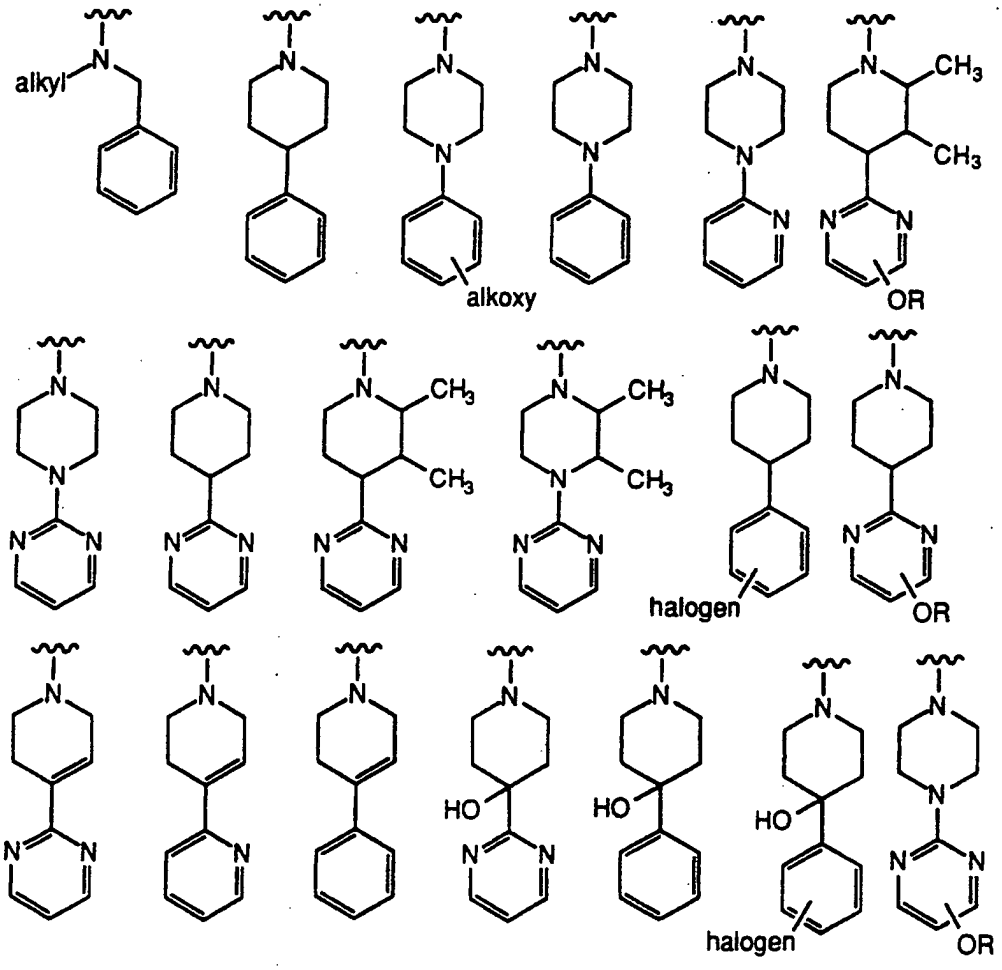
n is 0, or an integer of from 1-4; and

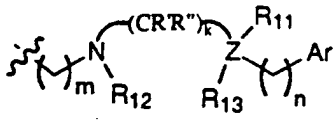
R_{12} represents lower alkyl.

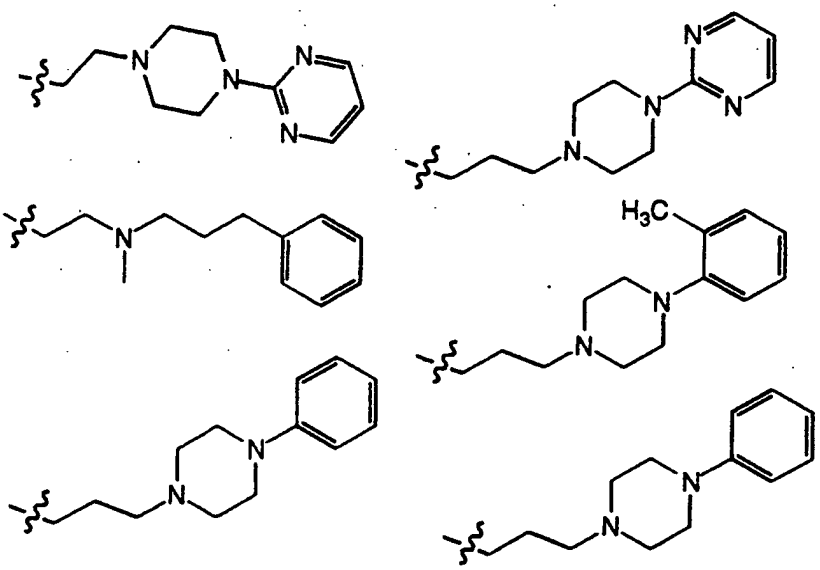
Preferred compounds of formula 6 are those where m is 2, 3 or 4 and n is 0. Particularly preferred compounds of Formula 6 are those where R_{12} is hydrogen or alkyl; m is 2, n is 0; Z is CH_2; R_1, R_2, R_3, R_4 are hydrogen; and R_8 is hydrogen, hydroxy, halogen or alkoxy. More particularly preferred compounds of Formula 6 are those where R_{12} is hydrogen or methyl; R_6 is

hydrogen; R_{10} is hydrogen or lower alkoxy, preferably methoxy; m is 2; n is 0; Z is CH_2; and R_1, R_2, R_3, R_4 are hydrogen; and R_8 is hydrogen, hydroxy or methoxy.

Representative  groups of formula I above include the following:



Preferred  groups of formula 1 above include the following:



In the above preferred groups, OR represents hydroxy or alkoxy.

Representative compounds of the present invention, which are encompassed by Formula 1, include, but are not limited to the compounds shown below in Table 1 and their pharmaceutically acceptable salts. Non-toxic pharmaceutically acceptable salts include salts of acids such as hydrochloric, phosphoric, hydrobromic, sulfuric, sulfinic, formic, toluene sulfonic, hydroiodic, acetic and the like. Those skilled in the art will recognize a wide variety of non-toxic pharmaceutically acceptable addition salts.

The present invention also encompasses the acylated prodrugs of the compounds of Formula 1. Those skilled in the art will recognize various synthetic methodologies which can be employed to prepare non-toxic pharmaceutically acceptable addition salts and acylated prodrugs of the compounds encompassed by Formula 1.

By "aryl" and "Ar" is meant an aromatic carbocyclic group having a single ring (e.g., phenyl), multiple rings (e.g., biphenyl), or multiple condensed rings in which at least one is aromatic, (e.g., 1,2,3,4-tetrahydronaphthyl, naphthyl, anthryl, or phenanthryl), which can

optionally be unsubstituted or substituted with e.g., halogen, lower alkyl, lower alkoxy, lower alkylthio, trifluoromethyl, lower acyloxy, aryl, heteroaryl, and hydroxy.

By "alkyl" and "lower alkyl" is meant straight and branched chain alkyl groups having from 1-6 carbon atoms.

By "lower alkoxy" and "alkoxy" is meant straight and branched chain alkoxy groups having from 1-6 carbon atoms.

By "heteroaryl" is meant 5, 6, or 7 membered aromatic ring systems having at least one hetero atom selected from the group consisting of nitrogen, oxygen and sulfur. Examples of heteroaryl groups are pyridyl, pyrimidinyl, pyrrolyl, pyrazolyl, pyrazinyl, pyridazinyl, oxazolyl, furanyl, quinolinyl, isoquinolinyl, thiazolyl, and thienyl, which can optionally be unsubstituted or substituted with e.g., halogen, lower alkyl, lower alkoxy, lower alkylthio, trifluoromethyl, lower acyloxy, aryl, heteroaryl, and hydroxy.

By halogen is meant fluorine, chlorine, bromine and iodine.

By alkylsulfonyl is meant a sulfonyl group substituted with a lower alkyl group.

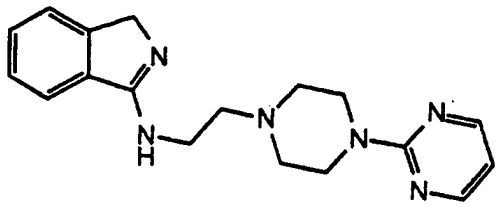
By arylalkylsulfonyl is meant a sulfonyl group substituted with an arylalkyl group.

By aminosulfonyl is meant a sulfonyl group substituted with an amino group.

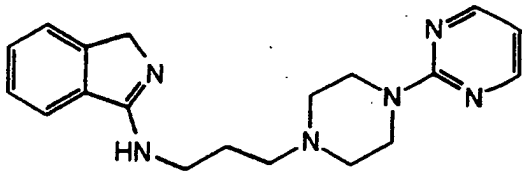
By alkylaminosulfonyl is meant a sulfonyl group substituted with a lower alkylamino, or di-lower alkylamino group.

Representative examples of bridged 4-phenyl-2-aminomethylimidazoles according to the invention are shown in Table 1 below.

Table 1[1]



1



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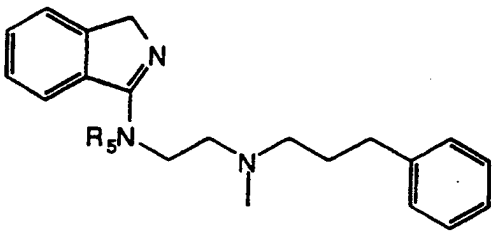
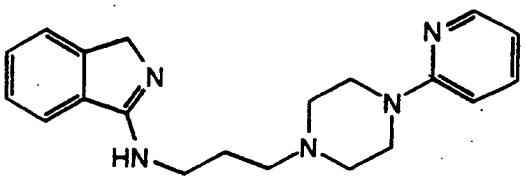


3 $R_5 = H$
4 $R_5 = CH_3$



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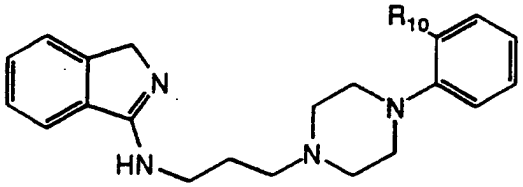
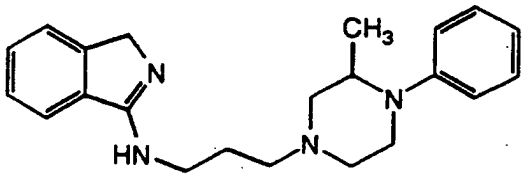


6 $R_{10} = H$
7 $R_{10} = OCH_3$



8

The number below each structure is its compound number.

The pharmaceutical utility of compounds of this invention are indicated by the following assays for dopamine receptor subtype affinity.

Assay for D_2 and D_3 receptor binding activity

Pellets of COS cells containing recombinantly produced D2 or D3 receptors from African Green monkey were used for the assays. The sample is homogenized in 100 volumes (w/vol) of 0.05 M Tris HCl buffer at 4° C and pH 7.4. The sample is then centrifuged at 30,000 x g and resuspended and rehomogenized. The sample is then centrifuged as described and the final tissue sample is frozen until use. The tissue is resuspended 1:20 (wt/vol) in 0.05 M Tris HCl buffer containing 100 mM NaCl.

Incubations are carried out at 48°C and contain 0.4 ml of tissue sample, 0.5 nM ^{3}H-YM 09151-2 and the compound of interest in a total incubation of 1.0 ml. Nonspecific binding is defined as that binding found in the presence of 1 mM spiperone; without further additions, nonspecific binding is less than 20% of total binding. The binding characteristics of examples of this patent for the D2 and D3 receptor subtypes are shown in Table 2 for Rat Striatal Homogenates.

TABLE 2

Compound Number[1]	D_2 K_i (mM)	D3 K_i (mM)
1	2.380	>100
2	1.420	>100
3	1.937	>100

[1] Compound numbers relate to compounds shown in Table 1 above.

Assay for D_4 receptor binding activity

Clonal cell lines expressing the human dopamine D_4 receptor subtype were harvested in PBS and the cells centrifuged and the pellets stored at -80° C until used in the binding assay. The pellets were resuspended and the cells lysed at 4° C in 50 mM Tris pH 7.4 buffer containing 120 mM NaCl, 1 mM EDTA and 5 mM $MgCl_2$. The homogenate is centrifuged at 48000 x g for 10 minutes at 4° C. The resulting pellet is resuspended in fresh buffer and centrifuged again. After resuspension of the pellet in fresh buffer a 100 ml aliquot is removed for protein determination. The remaining homogenate is centrifuged as above, the supernatant removed and the pellet stored at 4° C until needed at which time it is resuspended to a final concentration of 625 mg/ml (250 mg per sample) with 50 mM Tris buffer (pH 7.4) and 120 mM NaCl just prior to use. Incubations were carried out for 60 minutes at 25° C in the presence of 0.1 nM [^{3}H] YM-09151-2. The incubation was terminated by rapid filtration through Whatman GF/C filters and rinsed with 2 x 4 ml washes of chilled 50 mM Tris (pH 7.4) and 120 mM NaCl. Non-specific binding was determined with 1 mM spiperone and radioactivity determined by counting in an LKB beta counter.

Binding parameters were determined by non-linear least squares regression analysis, from which the inhibition constant Ki could be calculated for each test compound. The binding characteristics of some examples of this invention are shown in Table 3 for the dopamine D_4 binding assay. In general, compounds of the accompanying Examples were tested in the above assay, and all were found to possess a Ki value for the displacement of [^{3}H]YM-09151-2 from the human dopamine D_4 receptor subtype of below 500 nM. Some specific data is indicated in Table 3.

Table 3

Compound Number[1]	Ki (mM)
1	0.012
2	0.070
3	0.100

[1] Compound numbers relate to compounds shown in Table 1 above.

Compounds 1 and 2 are particularly preferred embodiments of the present invention because of their profile in binding to dopamine receptor subtypes.

The compounds of general Formulas 1 may be administered orally, topically, parenterally, by inhalation or spray or rectally in dosage unit formulations containing conventional non-toxic pharmaceutically acceptable carriers, adjuvants and vehicles. The term parenteral as used herein includes subcutaneous injections, intravenous, intramuscular, intrasternal injection or infusion techniques. In addition, there is provided a pharmaceutical formulation comprising a compound of general Formula 1 and a pharmaceutically acceptable carrier. One or more compounds of general Formula 1 may be present in association with one or more non-toxic pharmaceutically acceptable carriers and/or diluents and/or adjuvants and if desired other active ingredients. The pharmaceutical compositions containing compounds of general Formula 1 may be in a form suitable for oral use, for example, as tablets, troches, lozenges, aqueous or oily suspensions, dispersible powders or granules, emulsion, hard or soft capsules, or syrups or elixirs.

Compositions intended for oral use may be prepared according to any method known to the art for the manufacture of pharmaceutical compositions and such compositions may contain one or more agents selected from the group consisting of sweetening agents, flavoring agents, coloring agents and preserving agents in order to provide pharmaceutically elegant and palatable preparations. Tablets contain the active ingredient in admixture with non-toxic pharmaceutically acceptable excipients which are suitable for the manufacture of tablets. These excipients may be for example, inert diluents, such as calcium carbonate, sodium carbonate, lactose, calcium phosphate or sodium phosphate; granulating and disintegrating agents, for example, corn starch, or alginic acid; binding agents, for example starch, gelatin or acacia, and lubricating agents, for example magnesium stearate, stearic acid or talc. The tablets may be uncoated or they may be coated by known techniques to delay disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. For example, a time delay material such as glyceryl monosterate or glyceryl distearate may be employed.

Formulations for oral use may also be presented as hard gelatin capsules wherein the active ingredient is mixed with an inert solid diluent, for example, calcium carbonate, calcium phosphate or kaolin, or as soft gelatin capsules wherein the active ingredient is mixed with water or an oil medium, for example peanut oil, liquid paraffin or olive oil.

Aqueous suspensions contain the active materials in admixture with excipients suitable for the manufacture of aqueous suspensions. Such excipients are suspending agents, for example sodium carboxymethylcellulose, methylcellulose, hydropropylmethylcellulose, sodium alginate, polyvinylpyrrolidone, gum tragacanth and gum acacia; dispersing or wetting agents may be a naturally-occurring phosphatide, for example, lecithin, or condensation products of an alkylene oxide with fatty acids, for example polyoxyethylene stearate, or condensation products of ethylene oxide with long chain aliphatic alcohols, for example heptadecaethyleneoxycetanol, or condensation products of ethylene oxide with partial esters derived from fatty acids and a hexitol such as polyoxyethylene sorbitol monooleate, or condensation products of ethylene oxide with partial esters derived from fatty acids and hexitol anhydrides, for example polyethylene sorbitan

monooleate. The aqueous suspensions may also contain one or more preservatives, for example ethyl, or n-propyl p-hydroxybenzoate, one or more coloring agents, one or more flavoring agents, and one or more sweetening agents, such as sucrose or saccharin.

Oily suspensions may be formulated by suspending the active ingredients in a vegetable oil, for example arachis oil, olive oil, sesame oil or coconut oil, or in a mineral oil such as liquid paraffin. The oily suspensions may contain a thickening agent, for example beeswax, hard paraffin or cetyl alcohol. Sweetening agents such as those set forth above, and flavoring agents may be added to provide palatable oral preparations. These compositions may be preserved by the addition of an anti-oxidant such as ascorbic acid.

Dispersible powders and granules suitable for preparation of an aqueous suspension by the addition of water provide the active ingredient in admixture with a dispersing or wetting agent, suspending agent and one or more preservatives. Suitable dispersing or wetting agents and suspending agents are exemplified by those already mentioned above. Additional excipients, for example sweetening, flavoring and coloring agents, may also be present.

Pharmaceutical compositions of the invention may also be in the form of oil-in-water emulsions. The oily phase may be a vegetable oil, for example olive oil or arachis oil, or a mineral oil, for example liquid paraffin or mixtures of these. Suitable emulsifying agents may be naturally-occurring gums, for example gum acacia or gum tragacanth, naturally-occurring phosphatides, for example soy bean, lecithin, and esters or partial esters derived from fatty acids and hexitol, anhydrides, for example sorbitan monoleate, and condensation products of the said partial esters with ethylene oxide, for example polyoxyethylene sorbitan monoleate. The emulsions may also contain sweetening and flavoring agents.

Syrups and elixirs may be formulated with sweetening agents, for example glycerol, propylene glycol, sorbitor or sucrose. Such formulations may also contain a demulcent, a preservative and flavoring and coloring agents. The pharmaceutical compositions may be in the form of a sterile injectable aqueous or oleaginous suspension. This suspension may be formulated according to the known art using those suitable dispersing or wetting agents and suspending agents

which have been mentioned above. The sterile injectable preparation may also be sterile injectable solution or suspension in a non-toxic parentally acceptable diluent or solvent, for example as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose any bland fixed oil may be employed including synthetic mono or diglycerides. In addition, fatty acids such as oleic acid find use in the preparation of injectables.

The compounds of general Formula 1 may also be administered in the form of suppositories for rectal administration of the drug. These compositions can be prepared by mixing the drug with a suitable non-irritating excipient which is solid at ordinary temperatures but liquid at the rectal temperature and will therefore melt in the rectum to release the drug. Such materials are cocoa butter and polyethylene glycols.

Compounds of general Formula 1 may be administered parenterally in a sterile medium. The drug, depending on the vehicle and concentration used, can either be suspended or dissolved in the vehicle. Advantageously, adjuvants such as local anaesthetics, preservatives and buffering agents can be dissolved in the vehicle.

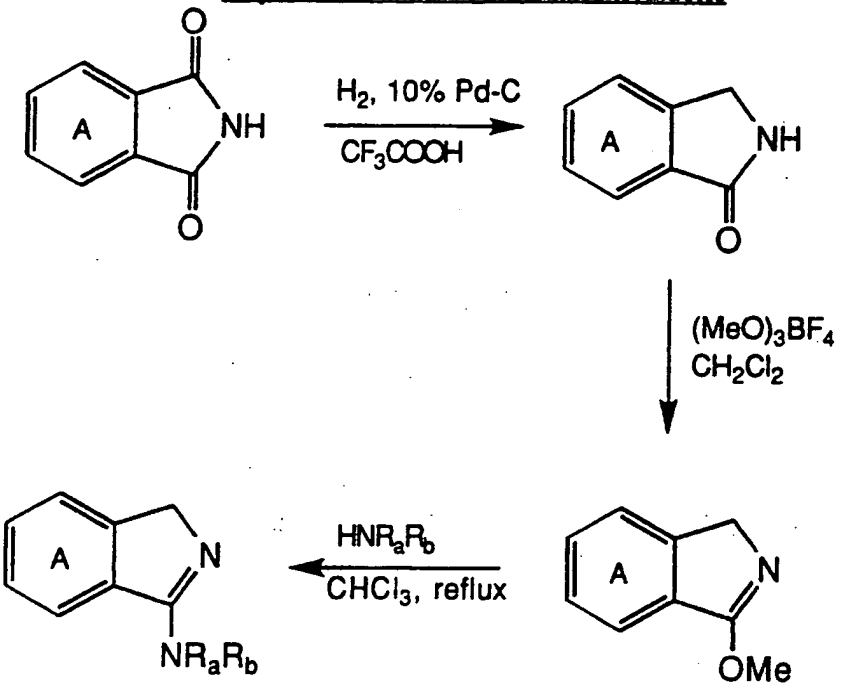
Dosage levels of the order of from about 0.1 mg to about 140 mg per kilogram of body weight per day are useful in the treatment of the above-indicated conditions (about 0.5 mg to about 7 g per patient per day). The amount of active ingredient that may be combined with the carrier materials to produce a single dosage form will vary depending upon the host treated and the particular mode of administration. Dosage unit forms will generally contain between from about 1 mg to about 500 mg of an active ingredient.

It will be understood, however, that the specific dose level for any particular patient will depend upon a variety of factors including the activity of the specific compound employed, the age, body weight, general health, sex, diet, time of administration, route of administration, and rate of excretion, drug combination and the severity of the particular disease undergoing therapy.

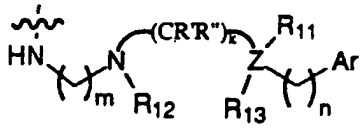
The compounds of the invention may be prepared by the reactions shown below in Scheme 1. Those having skill in the art will recognize that the starting materials may be varied and additional steps employed to produce other compounds encompassed by the present invention.

SCHEME 1

Preparation of 1-amino substituted isoindoles



where the A ring is as defined above and NR_aR_b represents the group



wherein CR'R", k, R_{11}, R_{12}, R_{13}, Ar, and m and n are as defined above.

The invention is further illustrated by the following examples which are not to be construed as limiting the invention in scope or spirit to the specific procedures and compounds described therein.

Example 1

To a solution of trimethyloxonium tetrafluoroborate (2.20 g, 14.9 mmol) in (CH_2Cl_2, 20 mL) was added a solution of phthalimidine (1.8 g, 13.5 mmol) in CH_2Cl_2 (20 mL) and the solution was stirred for 24 h. The solvent was evaporated in vacuo and the residue was dissolved in chloroform (80 mL). To this solution was added 1-(aminoethyl)-4-(2-pyrimidinyl)piperazine (2.08 g, 9.0 mmol) followed by triethylamine (5 mL). The solution was boiled under reflux overnight and then the solvent was evaporated in vacuo to afford a semisolid residue. The residue was dissolved in water (100 mL) and extracted with ethyl acetate (3 x 100 mL) to remove unreacted phthalimidine and primary amine. The aqueous solution was adjusted to about 20% NaOH by slow addition of aqueous 50% NaOH and then extracted with chloroform (2 x 100 mL). The combined chloroform extracts were dried (K_2CO_3) and evaporated to give Compound 1 as a pale yellow oil (2.9 g, quantitative). The hydrobromide salt was crystallized from hot ethanol. This compound had a melting point of 292-295°C (dec.).

Example 2

To a solution of trimethyloxonium tetrafluoroborate (1.10 g, 7.45 mmol) in (CH_2Cl_2, 10 mL) was added a solution of phthalimidine (0.9 g, 6.75 mmol) in CH_2Cl_2 (10 mL) and the solution was stirred for 24 h. The solvent was evaporated in vacuo and the residue was dissolved in chloroform (40 mL). To this solution was added 3-(aminopropyl)-4-(2-pyrimidinyl)piperazine (1.1 g, 4.5 mmol) followed by triethylamine (5 mL). The solution was boiled under reflux overnight and then the solvent was evaporated in vacuo to afford a semisolid residue. The residue was dissolved in water (50 mL) and extracted with ethyl acetate (3 x 50 mL) to remove unreacted phthalimidine and primary amine. The aqueous solution was adjusted to about 20% NaOH by slow addition of aqueous 50% NaOH and then extracted with chloroform (2 x 50 mL). The combined chloroform extracts were dried (K_2CO_3) and evaporated to give Compound 2 as a pale yellow oil (0.75 g, 38%). The hydrobromide salt crystallized from hot ethanol: mp 149-150 °C;

base ^{1}H-NMR (CDCl3) 8.38 (d, 2H), 7.3-7.5 (m, 5H), 6.55 (t, 1H), 4.62 (s, 2H), 3.9 (m, 4H), 3.63 (m, 2H), 2.63 (m, 6H), 1.8 (m, 2H).

Example 3

The following compounds are prepared essentially according to the procedures set forth above in Examples 1 and 2.

(a) 1-(N-[2-{N'-(3-phenylpropyl)-N'-methyl}aminoethyl])aminoisoindole dioxolate, Compound 3, m.p. 175-177°C.

(b) 1-(N-[2-{N'-(3-phenylpropyl)-N'-methyl}aminoethyl]-N-methyl])aminoisoindole, Compound 4.

(c) 1-(N-[3-{1-(4-(2-pyridyl)piperazinyl)}propylamino]) aminoisoindole dihydrobromide, Compound 5, m.p. 283-285°C (dec.).

(d) 1-(N-[3-{1-(4-phenylpiperazinyl)}propyl])aminoisoindole dihydrobromide, Compound 6, m.p. 208-211°C.

(e) 1-(N-[3-{1-(4-(2-methoxyphenyl))piperazinyl}propyl]) aminoisoindole dihydrobromide, Compound 7, m.p. 184-185°C.

(f) 1-(N-[3-{1-(4-phenyl-3-methyl)piperazinyl}propyl]) aminoisoindole dihydrobromide, Compound 8.

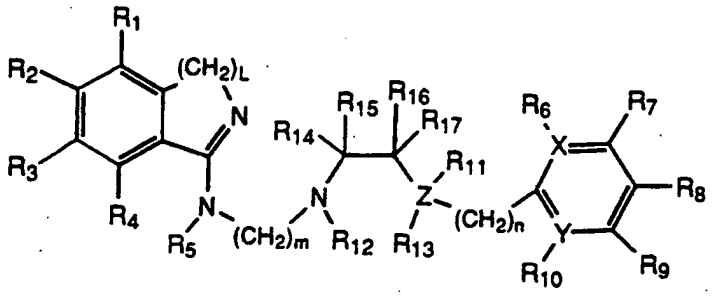
The disclosures in this application of all articles and references, including patents, are incorporated herein by reference.

The invention and the manner and process of making and using it are now described in such full, clear, concise and exact terms as to enable any person skilled in the art to which it pertains, to make and use the same. It is to be understood that the foregoing describes preferred embodiments of the present invention and that modifications may be made therein without departing from the spirit or scope of the present invention as set forth in the claims. To particularly

point out and distinctly claim the subject matter regarded as invention, the following claims conclude the specification.

What is claimed is:

1. A compound of the formula:



or the pharmaceutically acceptable salts thereof wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

X represents carbon or nitrogen provided that

where X carbon, R_6 represents hydrogen, halogen, hydroxy, lower alkyl having 1-6 carbon atoms, or lower alkoxy; and

where X is nitrogen, R_6 represents an electron pair;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

where Y is nitrogen, R_{10} represents an electron pair;

Z represents carbon or nitrogen provided that

where Z is carbon, R_{11} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy, or phenyl optionally substituted with one or two groups selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

when Z is nitrogen, R_{11} represents an electron pair;

R_5 is hydrogen or lower alkyl;

L is an integer of from 1-4;

m is an integer of from 2-5;

n is 0, or an integer of from 1-4;

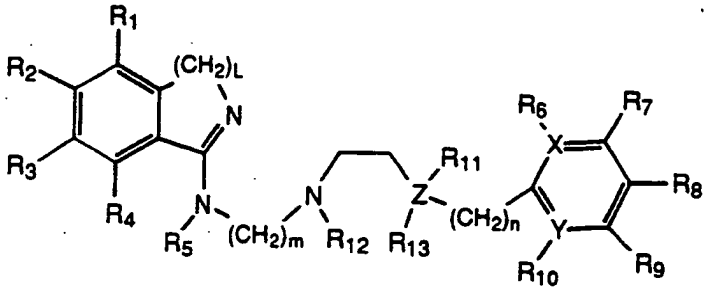
R_{12} and R_{13} independently represent lower alkyl; or

R_{12} and R_{13} taken together represent $(CH_2)_s$ where s is an integer of from 1-6;

R_7 and R_8 together may represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

R_{14}, R_{15}, R_{16} and R_{17} are the same or different and represent hydrogen or lower alkyl.

2. A compound of the formula:



or the pharmaceutically acceptable salts thereof wherein:

R_1, R_2, R_3, R_4 and R_7, R_8 and R_9 are the same or different and represent hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy;

X represents carbon or nitrogen provided that

where X carbon, R_6 represents hydrogen, halogen, hydroxy, lower alkyl having 1-6 carbon atoms, or lower alkoxy; and

where X is nitrogen, R_6 represents an electron pair;

Y represents carbon or nitrogen provided that

where Y is carbon, R_{10} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

where Y is nitrogen, R_{10} represents an electron pair;

Z represents carbon or nitrogen provided that

where Z is carbon, R_{11} represents hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy, or phenyl optionally substituted with one or two groups selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy; and

when Z is nitrogen, R_{11} represents an electron pair;

R_5 is hydrogen or lower alkyl;

L is an integer of from 1-4;

m is an integer of from 2-5;

n is 0, or an integer of from 1-4;

R_{12} and R_{13} independently represent lower alkyl; or

R_{12} and R_{13} taken together represent $(CH_2)_s$ where s is an integer of from 1-6;

R_7 and R_8 together may represent a benzo ring optionally substituted with up to four substitutents selected from hydrogen, halogen, hydroxy, lower alkyl, or lower alkoxy.

3. A compound of Claim 1 which is 1-(N-[2-{1-(4-(2-pyrimidyl)piperazinyl)}ethyl])aminoisoindole.

4. A compound of Claim 1 which is 1-(N-[3-{1-(4-(2-pyrimidyl)piperazinyl)}propylamino)amino)isoindole.

5. A compound of Claim 1 which is 1-(N-[2-{N'-(3-phenylpropyl)-N'-methyl}aminoethyl])aminoisoindole.

6. A compound of Claim 1 which is 1-(N-[2-{N'-(3-phenylpropyl)-N'-methyl}aminoethyl]-N-methyl])aminoisoindole.

7. A compound of Claim 1 which is 1-(N-[3-{1-(4-(2-pyridyl)piperazinyl)}propylamino])aminoisoindole.

8. A compound of Claim 1 which is 1-(N-[3-{1-(4-phenylpiperazinyl)}propyl])aminoisoindole.

9. A compound of Claim 1 which is 1-(N-[3-{1-(4-(2-methoxyphenyl))piperazinyl}propyl])aminoisoindole.

10. A compound of Claim 1 which is 1-(N-[3-{1-(4-phenyl-3-methyl)piperazinyl}propyl])aminoisoindole.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/08836

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C07D403/12 A61K31/40 C07D209/44 C07D401/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C07D A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ARZNEIMITTEL FORSCHUNG DRUG RESEARCH., vol. 30, no. 9, 1980, AULENDORF DE, pages 1487-1493, XP002010421 VON H:J: MAY ET AL.: "Chemie und biologische Eigenschaften substitutierter 3-Amino-1H-isoindole" * see page 1489, compound nr. 18 * ---	1,2
A	WO,A,92 12134 (NEUROGEN CORPORATION) 23 July 1992 see claims ---	1
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 August 1996	20.08.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Van Bijlen, H

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/08836

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JOURNAL OF MEDICINAL CHEMISTRY, vol. 35, no. 22, 1992, WASHINGTON US, pages 4020-4026, XP002010422 HENNING BÖTTCHER ET AL.: "Synthesis and dopaminergic activity of some 3-(1,2,3,6-tetrahydro-1-pyridylalkyl)indoles. ..." see page 4022 -----	1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 96/08836

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO-A-9212134	23-07-92	US-A-	5159083	27-10-92
		CA-A-	2098301	29-06-92
		EP-A-	0640075	01-03-95
		JP-T-	6504054	12-05-94